FRACTURE QUANTIFICATION IN GAS RESERVOIRS

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RESEARCH OBJECTIVES

Berkeley Lab is the lead institution of a comprehensive program between the Department of Energy and industry for integrated field testing and analysis. This program is aimed at improving the fundamental understanding of seismic-wave propagation in naturally fractured gas reservoirs to extend fracture characterization to fracture quantification. A cooperative research program has been organized between Berkeley Lab and Conoco, Inc., Lynn, Inc., Schlumberger, Inc., Stanford University, and Virginia Tech. This field-scale effort is focused on using field production and test facilities for both development and validation of methods for predicting fractured reservoir performance.

APPROACH

We are starting with current state-of-the-art methods and extending the surface-based information with current borehole methods (vertical seismic profiling, crosswell and single well) to quantify fracture characteristics. The approach will be an industry-coupled program, tightly linked to actual field cases, iterating between development and application. Past efforts have focused on field experiments in well-characterized field sites at both the intermediate and full field scale. We will continue with this approach, working at industry sites that are representative of other sites.

The proposed field site for this year's work was the Conoco property in New Mexico's San Juan Basin. The criteria we set for the field site are: (1) it must be in an area of ongoing commercial interest; (2) it must have a wealth of geologic and other geophysical information; and (3) we must be able to have ongoing access throughout the project. Ideally, we also would like to be involved with the producer to such an extent that if our approaches and methodology are successful, they could be integrated into future operational plans. The selected field site and industry partners meet all of these criteria. We anticipate that wells will be drilled to validate the results of this work.

The overall work plan can be divided into four broad tasks:

1. Modeling
2. Field measurements
3. Processing and interpretation
4. Reservoir simulation

ACCOMPLISHMENTS

Over the past year, the effort has focused on reprocessing and interpretation of a 20-square-mile P-wave, 3D surface, seismic data set. The objective of the reprocessing by Conoco was to provide the "best" image for fracture identification by Lynn. The processing improved the past results by which Lynn targeted potentially fractured areas in the subsurface. This was in preparation for the next phase of field work, in which vertical seismic profiling (VSP) and single-well surveys will be run in two new wells drilled by Conoco in the 20-square-mile study area.

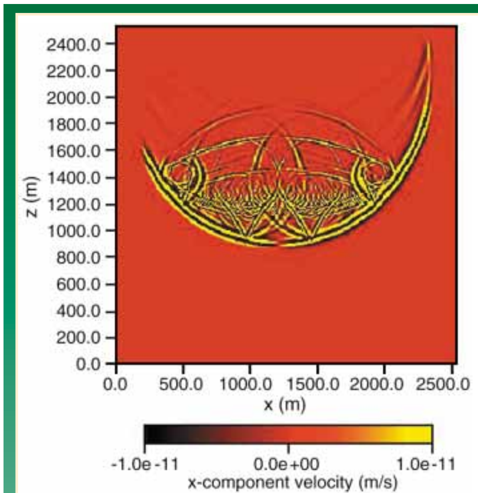

Figure 1. Model 113 Horizontal Component 400 ms. Seismic wavefield through a layered media with discrete fractures of two different sizes, large through-going "faults" ("V' shaped image) and smaller fractures within one layer (smaller diffractions). The wavefield was calculated using a finite-element discrete-fracture model rather than an equivalent media model.

Another major thrust was the modeling of seismic waves in fractured media. Our approach is to model the effects of discrete fractures (in addition to an equivalent media approach). Figure 1 shows an example of this approach, a multilayer model with one layer having many smaller fractures and the entire model cut by several larger fractures (faults). The results of using a discrete-fracture modeling approach show that such effects as scattering, tuning, and diffraction are caused by the fractures. Future work will involve validating the different scale effects with field data.

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